

ELECTRONIC MEASUREMENT & INSTRUMENTATION (BEC-29)



Instructor
Dr. B. P. Pandey
Assistant Professor

**Department of Electronics and Communication Engineering
Madan Mohan Malaviya University of Technology , Gorakhpur**

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UNIT- 2
Lecture-6
Transducers

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Capacitive Transducer

- The capacitive transducer is used for measuring the displacement, pressure and other physical quantities.
- It is a passive transducer that means it requires external power for operation. The capacitive transducer works on the principle of variable capacitances.
- The capacitance of the capacitive transducer changes because of many reasons like overlapping of plates, change in distance between the plates and dielectric constant.
- The capacitive transducer contains two parallel metal plates. These plates are separated by the dielectric medium which is either air, material, gas or liquid.
- In the normal capacitor the distance between the plates are fixed, but in capacitive transducer the distance between them are varied.
- The capacitive transducer uses the electrical quantity of capacitance for converting the mechanical movement into an electrical signal.
- The input quantity causes the change of the capacitance which is directly measured by the capacitive transducer.
- The capacitors measure both the static and dynamic changes. The displacement is also measured directly by connecting the measurable devices to the movable plate of the capacitor. It works on with both the contacting and non-contacting modes.

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Principle of Operation of Capacitive Transducer

- The equations below express the capacitance between the plates of a capacitor

Where A – overlapping area of plates in m^2

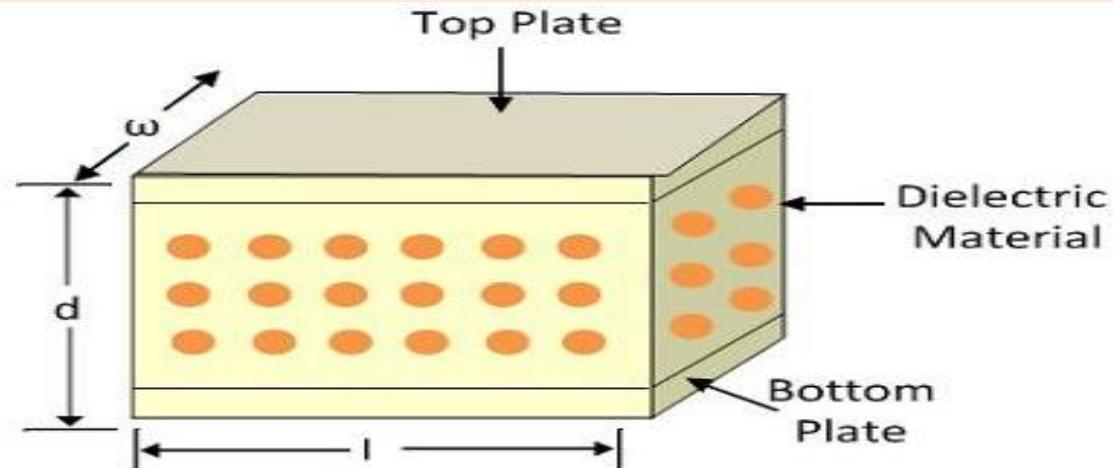
d – the distance between two plates in meter

ϵ – permittivity of the medium in F/m

ϵ_r – relative permittivity

ϵ_0 – the permittivity of free space

- The schematic diagram of a parallel plate capacitive transducer is shown in the figure below.



Parallel Plate Capacitive Transducer

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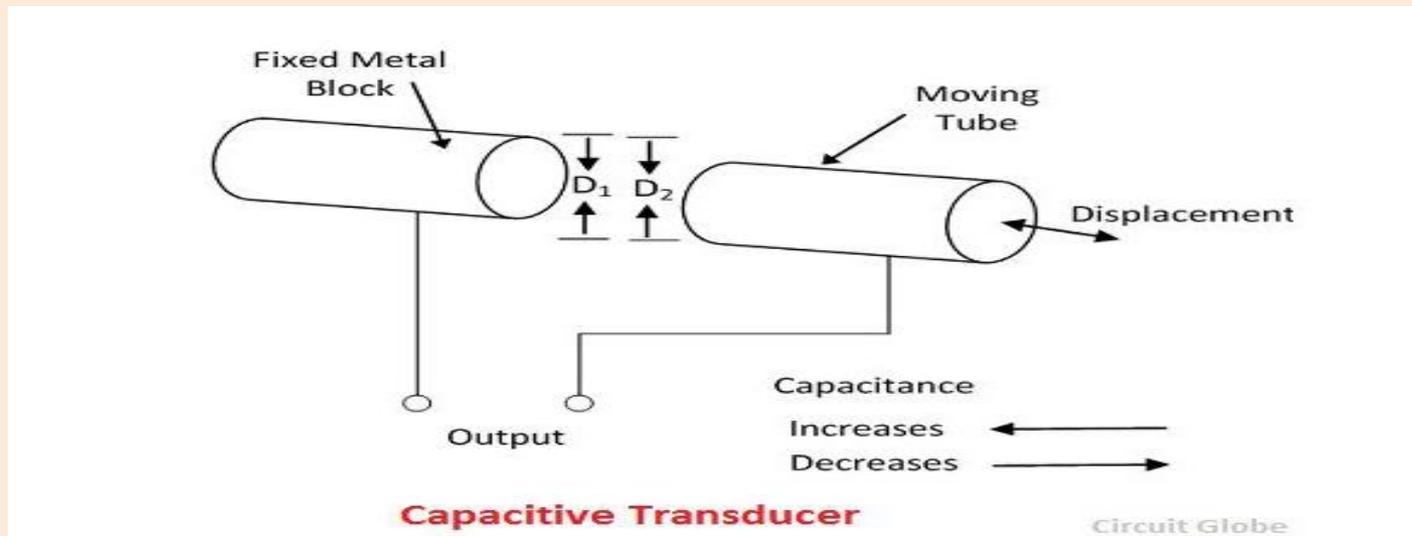
The capacitive transducer uses the following three effects.

1. Variation in capacitance of transducer is because of the overlapping of capacitor plates.
2. The change in capacitance is because of the change in distances between the plates.
3. The capacitance changes because of dielectric constant.

The following two methods are used for the measuring displacement.

1. **A transducer using the change in the Area of Plates** – The equation below shows that the capacitance is directly proportional to the area of the plates. The capacitance changes correspondingly with the change in the position of the plates.

Contd..



2. The transducer using the change in distance between the plates –

- The capacitance of the transducer is inversely proportional to the distance between the plates.
- The one plate of the transducer is fixed, and the other is movable.
- The displacement which is to be measured links to the movable plates.

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Advantage of Capacitive Transducer

- The following are the major advantages of capacitive transducers.
- It requires an external force for operation and hence very useful for small systems.
- The capacitive transducer is very sensitive.
- It gives good frequency response because of which it is used for the dynamic study.

Disadvantages of capacitive Transducer

- The main disadvantages of the transducer are as follows.
- The metallic parts of the transducers require insulation.
- The frame of the capacitor requires earthing for reducing the effect of the stray magnetic field.
- Sometimes the transducer shows the nonlinear behaviors because of the edge effect which is controlled by using the guard ring.

Assignment Questions

- State the working principle of Capacitive transducers.
- With the help of a diagram explain the operation of capacitive transducers.
- State the limitations of capacitive transducers.
- State the advantage and disadvantage of capacitive transducers over other transducers.

Conceptual Questions

- A capacitive transducer works on the principle of _____
 - a) inductance
 - b) capacitance
 - c) resistance
 - d) reluctance
- Capacitive pressure transducer uses distance of separation for sensing the capacitance.
 - a) True
 - b) False
- Capacitive transducer displays _____
 - a) linear behavior
 - b) non-linear behavior
 - c) exponential behavior
 - d) tangential behavior

Contd..

- Frequency response of capacitive transducers is _____
 - a) high
 - b) medium
 - c) low
 - d) zero
- Composite capacitance consists of _____
 - a) one dielectric medium
 - b) more than one dielectric medium
 - c) five dielectric media
 - d) ten dielectric media
- What is the relation between capacitance and input impedance?
 - a) directly proportional
 - b) constant
 - c) proportional to square
 - d) inversely proportional

THANK YOU